Claims

1. Method to desalt water by reverse osmosis, in particular to desalt sea water, in which salt water (10) at a first pressure level (p_1) is introduced into a pressure-compensating device (2), and from the pressure-compensating device (2) is conveyed at a second higher pressure level (p_2) into a membrane module (3), whereby desalted water (12) and concentrated salt water (13) are discharged from the membrane module (3),
characterized in that the concentrated salt water (13) being discharged from the membrane module (3) is continuously introduced at a second pressure level (p_2) into the pressure-compensating device (2), where it is used to pressurize the salt water (10), which has been introduced into the pressure-compensating device (2), to the second pressure level (p_2), and to carry off salt water (11) to the membrane module (3).

2. Method according to claim 1,
characterized in that from the membrane module (3) the concentrated salt water (13) is conveyed at the second pressure level (p_2) into a discharge chamber (22, 32, 42) of one of several piston devices (20, 30, 40), where it acts upon the piston (24, 34, 44) in such a manner that the salt water (10), which has been introduced into an intake chamber (21, 31, 41) of the same piston device (20, 30, 40), is conveyed at the second pressure level (p_2) into the membrane module (3).

3. Method according to claim 2,
characterized in that the concentrated salt water (13) is introduced alternately into the discharge chamber (22, 32, 42) of one of the several piston devices (20, 30, 40), whereby simultaneously the salt water (11) is conveyed from the intake chamber (21, 31, 41) of the same piston device (20, 30, 40) into the membrane module (3), and in that simultaneously salt water (10) at the first pressure level (p_1) is introduced into the intake chamber (21, 31, 41) of a different piston device (20, 30, 40), whereby the concentrated salt water (14) is discharged from the discharge chamber (22, 32, 42) of the same piston device (20, 30, 40) at a low pressure level.

4. Method according to claim 3,
characterized in that the piston devices (20. 30, 40) of the pressure-compensating device (2) are controlled in such a manner that simultaneously salt water (10) is introduced into the intake chamber (21, 31, 41) of at least one piston device (20, 30, 40), concentrated salt water (14) is discharged from the discharge chamber (22, 32, 42) of the same piston device (20, 30, 40), concentrated salt water (13) is introduced into the discharge chamber (22, 32, 42) of at least one other piston device (20. 30, 40), and salt water (11) from the intake chamber (21, 31, 41) of the same piston device (20, 30, 40) is conveyed to the membrane device (3).

5. Method according to claim 4,
characterized in that the piston devices are regulated by controllable intake- and discharge valves (25 – 28, 35 – 38, 45 – 48).

6. Method according to one of claims 2 to 5.
characterized in that each of the employed piston devices (20, 30, 40) contains one intake chamber (21, 31, 41), one discharge chamber (22, 32, 42), and one pressure chamber (23, 33, 43), and in that the pressure chambers (23, 33, 43) of the piston devices (20, 30, 40) are connected to each other and exert a continuous pressure (p_3) on a part (343) of the piston (34) for the purpose of assisting the pressure (p_2), which is exerted upon the piston by the concentrated salt water (13) introduced into the discharge chamber (22, 32, 42).

7. Device for the implementation of the method according to one of the preceding claims, with a feed pump (1) to introduce salt water (10) into the pressure-compensating device (2) and with a membrane module (3) to separate salt water (11) introduced from the pressure-compensating device (2) into desalted water (12) and concentrated salt water (13),
characterized in that between the membrane module (3) and the pressure-compensating device (2) is provided a connecting line (4), which during operation is continuously pressurized to the second pressure level (p_2), and serves in feeding the concentrated salt water (13) from the membrane module (3) to the pressure-compensating device (2) and in feeding the salt water (11) from the pressure-compensating device (2) to the membrane module (3).

8. Device according to claim 7,
characterized in that the pressure-compensating device (2) contains several piston devices (20, 30, 40), each of which contains an intake chamber (21, 31, 41) connected to the membrane module (3) and the membrane module (3), each of which further contains a discharge chamber (23, 33, 43) connected to the membrane module (3) and to a discharge line (4) for the concentrated salt water (14), and each of which further contains a pressure chamber (23, 33, 43), whereby the pressure chambers (23, 33, 43) of the piston devices (20, 30, 40) are connected to each other and are continuously pressurized to the pressure level (p_3).

9. Device according to claim 8,
characterized in that the piston devices (20, 30, 40) are controlled in such a manner that simultaneously salt water (10) is introduced into the intake chamber (21, 31, 41) of at least one piston device (20, 30, 40), concentrated salt water (14) is discharged from the discharge chamber (22, 32, 42) of the same piston device (20, 30, 40), concentrated salt water (13) is introduced into the discharge chamber (22, 32, 42) of at least one other piston device (20, 30, 40), and salt water (11) is conveyed from the intake chamber (21, 31, 41) of the same piston device (20, 30, 40) to the membrane device (3).

10. Device according to claim 9,
characterized in that the piston devices (20, 30, 40) are regulated by controllable intake- and discharge valves (25 – 28, 35 – 38, 45- 48).

11. Device according to claim 10,
characterized in that the connecting lines (5) from the membrane module (3) to the discharge chambers (22, 32, 42) of the piston devices (20, 30, 40) and the lines (4) to discharge concentrated salt water (14) from the discharge chambers (22, 32, 42) contain actively controlled valves (25, 26, 35, 36, 45, 46).

12. Device according to one of claims 7 to 11,
characterized in that the pressure-compensating device (2) contains three identical piston devices (20, 30, 40).

13. Device according to one of claims 8 to 12,
characterized in that the pistons (24, 34, 44) of the piston devices (20, 30, 40) are designed in such a manner that the pressure level (p_3) prevailing in the pressure chamber (23, 33, 43) can act upon one quarter of the surface area of the rear side of the piston (343) and the pressure prevailing in the discharge chamber (22, 32, 42) can act upon three quarters of the surface area of the rear side of the piston (342).

/Translation of letter head information omitted (The Translator)/

Bremen, April 9, 2001

Our reference: W 2075 KGG/STK/ml/sin

Applicant/Patentee: ALOYS WOBBEN
Official file ref.: PCT/EP00/02417

New claims 1 to 10

1. Method for the continuous desalting of water, in particular for the desalting of sea water, whereby
   - salt water (11) is introduced into a membrane module (3) and is separated into desalted water (12) and concentrated salt water (13),
   - the salt water (11) is conveyed at an increased pressure level (p_2) from the pressure-compensating device (2), which comprises several piston devices (20, 30, 40), to the membrane module (3),
   - the concentrated salt water (13) is discharged from the pressure-compensating device (2), transferring its pressure energy in the process,
   - salt water (10) is introduced into the pressure-compensating device 2 at a pressure level (p_1) by means of a feed pump (1),
   - in front of the piston, the piston devices (20, 30, 40) contain an intake chamber (21, 31, 41), which is connected to the feed pump (1) and the membrane module (3), and in the rear of the piston they contain a discharge chamber (22, 32, 42), which is connected to the membrane module (3) and a discharge line (4) for concentrated salt water (14),

   characterized in that, during operation a continuous pressure (p_3) is exerted on a part (343) of the piston (24, 34, 44) by means of a hydraulic connection between the pressure chambers (23, 33, 43), which are located at the piston rear sides of the piston devices (20, 30, 40), to assist the pressure level (p_2), which is exerted on the piston (24, 34, 44) by the concentrated salt water (13) that has been introduced into the discharge chambers (22, 34, 44).

2. Method according to claim 1,
characterized in that the concentrated salt water (13) alternately is introduced into the discharge chamber (22, 32, 42) of one of several piston devices (20, 30, 40), whereby simultaneously the salt water (11) is conveyed from the intake chamber (21, 31, 41) of the same piston device (20, 30, 40) to the membrane module (3), and in that simultaneously salt water (10) at a first pressure level (p_1) is introduced into the intake chamber (21, 31, 41) of a different piston device (20, 30, 40), whereby the concentrated salt water (14) is discharged at a low pressure level from the discharge chamber (22, 32, 42) of the same piston device (20, 30, 40).

3. Method according to claim 2,
characterized in that the piston devices (20, 30, 40) of the pressure-compensating device (2) are controlled in such a manner that simultaneously salt water (10) is introduced into the intake chamber (21, 31, 41) of at least one of the piston devices (20, 30, 40), concentrated salt water (14) is discharged from the discharge chamber (22, 32, 42) of the same piston device (20, 30, 40), concentrated salt water (13) is introduced into the discharge chamber (22, 32, 42) of at least one other piston device (20, 30, 40), and salt water (11) is conveyed from the intake chamber (21, 31, 41) of the same piston device (20, 30, 40) into the membrane device (3).

4. Method according to claim 3,
characterized in that the piston devices (20, 30, 40) are regulated by controllable intake- and discharge valves (25 – 28, 35 – 38, 45 – 48).

5. Reverse osmosis device for the continuous desalting of water, in particular for the desalting of sea water,
   - with a membrane module (3) to separate supplied salt water (11) into desalted water (12) and concentrated salt water (13),
   - with a pressure-compensating device (2), comprising several piston devices (20, 30, 40), to continuously introduce the salt water (11) at an increased pressure level (p_2) into the membrane module (3) and to discharge the concentrated salt water (13), transferring its pressure energy in the process,
   - with a feed pump (1) to introduce salt water (10) at a pressure level (p_1) into the pressure-compensating device (2), whereby

- in front of the piston, the piston devices (20, 30, 40) possess an intake chamber (21, 31, 41), which is connected to the feed pump (1) and the membrane module (3), and
- in the rear of the piston, the piston devices (20, 30, 40) possess a discharge chamber (22, 32, 42), which is connected to the membrane module (3) and to a discharge line (4) for concentrated salt water (14),

characterized in that

- in the rear of the piston, the piston devices (20, 30, 40) additionally possess a pressure chamber (23, 33, 43) and the pressure chambers are hydraulically connected to each other, so that during operation a continuous pressure (p_3) can be exerted on a part (343) of the piston (24, 34, 44) to assist the pressure (p_2), which is exerted on the piston (24, 34, 44) by the concentrated salt water (13) introduced into the discharge chamber (22, 32, 42).

6. Device according to claim 5,
characterized in that the piston devices (20, 30, 40) are controlled in such a manner that simultaneously salt water (10) is introduced into the intake chamber (21, 31, 41) of at least one piston device (20, 30, 40), concentrated salt water (14) is discharged from the discharge chamber (22, 32, 42) of the same piston device (20, 30, 40), concentrated salt water (13) is introduced into the discharge chamber (22, 32, 42) of at least one other piston device (20, 30, 40), and salt water (11) is conveyed from the intake chamber (21, 31, 41) of the same piston device (20, 30, 40) to the membrane module (3).

7. Device according to claim 6,
characterized in that the piston devices (20, 30, 40) are regulated by controllable intake- and discharge valves (25 – 28, 35 – 38, 45 – 48).

8. Device according to claim 7,
characterized in that the connecting lines (5) from the membrane module (3) to the discharge chambers (22, 32, 42) of the piston devices (20, 30, 40), and the lines (4) to discharge concentrated salt water (14) from the discharge chambers (22, 32, 42) are provided with actively controlled valves (25, 26, 35, 36, 45, 46).

9. Device according to one of claims 5 to 8,
characterized in that the pressure-compensating device (2) contains three identical piston devices (20, 30, 40).

10. Device according to one of claims 5 to 9,
characterized in that the pistons (24, 34, 44) of the piston devices (20, 30, 40) are designed in such a manner that the pressure level (p_3) prevailing in the pressure chamber (23, 33, 43) can act upon one quarter of the surface area of the piston rear side (343) and the pressure level prevailing in the discharge chamber (22, 32, 42) can act upon three quarters of the surface area of the piston rear side (342).